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Author manuscript

*Vaccine*. Author manuscript; available in PMC 2018 February 22.

Published in final edited form as:

*Vaccine*. 2013 May 01; 31(19): 2348–2357. doi:10.1016/j.vaccine.2013.03.011.

## Hepatitis A vaccination coverage among adults 18–49 years traveling to a country of high or intermediate endemicity, United States

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### Abstract

**Background**—Since 1996, hepatitis A vaccine (HepA) has been recommended for adults at increased risk for infection including travelers to high or intermediate hepatitis A endemic countries. In 2009, travel outside the United States and Canada was the most common exposure nationally reported for persons with hepatitis A virus (HAV) infection.

**Objective**—To assess HepA vaccination coverage among adults 18–49 years traveling to a country of high or intermediate endemicity in the United States.

**Methods**—We analyzed data from the 2010 National Health Interview Survey (NHIS), to determine self-reported HepA vaccination coverage (1 dose) and series completion (2 dose) among persons 18–49 years who traveled, since 1995, to a country of high or intermediate HAV endemicity. Multivariable logistic regression and predictive marginal analyses were conducted to identify factors independently associated with HepA vaccine receipt.

**Results**—In 2010, approximately 36.6% of adults 18–49 years reported traveling to high or intermediate hepatitis A endemic countries; among this group unadjusted HepA vaccination coverage was 26.6% compared to 12.7% among non-travelers ( $P$ -values < 0.001) and series completion were 16.9% and 7.6%, respectively ( $P$ -values < 0.001). On multivariable analysis among all respondents, travel status was an independent predictor of HepA coverage and series completion (both  $P$ -values < 0.001). Among travelers, HepA coverage and series completion (2 doses) were higher for travelers 18–25 years (prevalence ratios 2.3, 2.8, respectively,  $P$ -values < 0.001) and for travelers 26–39 years (prevalence ratios 1.5, 1.5, respectively,  $P$ -value < 0.001,  $P$ -value = 0.002, respectively) compared to travelers 40–49 years. Other characteristics independently associated with a higher likelihood of HepA receipt among travelers included Asian

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race/ethnicity, male sex, never having been married, having a high school or higher education, living in the western United States, having greater number of physician contacts or receipt of influenza vaccination in the previous year. HepB vaccination was excluded from the model because of the significant correlation between receipt of HepA vaccination and HepB vaccination could distort the model.

**Conclusions**—Although travel to a country of high or intermediate hepatitis A endemicity was associated with higher likelihood of HepA vaccination in 2010 among adults 18–49 years, self-reported HepA vaccination coverage was low among adult travelers to these areas. Healthcare providers should ask their patients' upcoming travel plans and recommend and offer travel related vaccinations to their patients.

## Keywords

Hepatitis A; Hepatitis A vaccine; Vaccination; Coverage; Adults at risk; Travel status

## 1. Introduction

Hepatitis A is caused by infection with the hepatitis A virus (HAV). HAV infection is transmitted primarily through the fecal–oral route by either person-to-person contact or ingestion of contaminated food or water [1–7]. HAV is endemic in many parts of the developing world, where poor sanitation facilitates transmission of the virus [1]. In areas where HAV infection is endemic, transmission occurs most frequently among close contacts, particularly within households and among extended family settings. In the developed world, the incidence of hepatitis A disease is generally low; cases occur in the context of community-wide outbreaks transmitted among preschool and school-age children to their adult contacts, or in foodborne outbreaks [2–6]. Cases also occur among injection drug users and men who have sex with men. In countries with childhood hepatitis A (HepA) vaccination programs, an increasing proportion of cases occur among travelers returning from hepatitis A endemic areas [1–7].

HAV infection among adults results in substantial morbidity, medical costs and work loss. In 2007, approximately 35% of persons with acute HAV infection were hospitalized in the United States, most of whom were adults and the severity of diseases increased with age [2,3,6]. Adults with HAV infection lose an average of 16 work days for outpatients, and 33 days for hospitalized patients [8].

Persons from the United States who travel to developing countries are at substantial risk for HAV infection [5]. Such persons include tourists, military personnel, missionaries, foreign-born persons who return to their country of origin to visit friends or relatives, and others who work or study abroad in countries with high or intermediate HAV endemicity [5]. Hepatitis A remains one of the more common vaccine-preventable diseases acquired during travel [9,10]. Among acute hepatitis A cases reported nationally for whom travel information was available in 2009, 15% involved travel outside the United States and Canada even though there were a large number of cases with missing or unknown exposure [6]. Similar proportions of travel related hepatitis A cases are reported in Europe [1,11,12]. One study estimated the risk of acquiring HAV infection among persons who were not

vaccinated before departure to be four to 30 cases per 100,000 months of stay in developing countries [13]. In addition, persons who acquire HAV during travel can transmit the infection to susceptible persons upon their return [5].

Optimal use of vaccination can significantly reduce the hepatitis A disease burden [5]. In 1995, the first hepatitis A vaccine was available in the United States. In 1996, the Advisory Committee on Immunization Practices (ACIP) recommended hepatitis A vaccination for travelers to or persons working in countries with high or intermediate HAV endemicity [14]. Men who have sex with men (MSM), injection- and non-injection-drug users, persons who have occupational risk for infection, persons with chronic liver disease, and persons who have clotting-factor disorders were also recommended for vaccination [14]. In 2006, ACIP recommended that all children should receive hepatitis A vaccine at age 1 year (i.e., 12–23 months); children who are not vaccinated by age 2 years can be vaccinated at subsequent visits; states, counties, and communities with existing hepatitis A vaccination programs for children aged 2–18 years are encouraged to maintain these programs. In areas without existing hepatitis A vaccination programs, catch-up vaccination of unvaccinated children aged 2–18 years can be considered; and adult high-risk populations which HepA vaccination was recommendation in 1996 were also recommended to receive vaccination in the 2006 ACIP recommendation [5]. Previous studies showed that HepA vaccination coverage was 81.2% among children 19–35 months, 42.0% among adolescents, and 34% among MSM (high-risk adult population) [15–17].

This study used data from the 2010 National Health Interview Survey (NHIS) to address and examine the following questions: [1] What is the most recent HepA vaccination coverage among adults 18–49 years who reported travel to a country of high or intermediate HAV endemicity? [2] What factors significantly affect HepA vaccination among adults 18–49 years who reported travel to a country of high or intermediate HAV endemicity?

## 2. Methods

We analyzed data from the 2010 National Health Interview Survey (NHIS) to determine self-reported hepatitis A vaccine (HepA) coverage (1 dose) and series completion (2 doses) among adult travelers, 18–49 years, to high or intermediate HAV endemic countries. The NHIS is an annual household survey conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention [18]. The NHIS provides estimates on health indicators, health care utilization and access, and health-related behaviors for the U.S. non-institutionalized, civilian population. The NHIS sample is selected through the use of complex sampling design involving stratification, clustering, and multistage sampling with a nonzero probability of selection for each person. Estimates were weighted to the adult civilian population of the United States. Face to face interviews were conducted each week throughout the year in a probability sample of households. Data collected over the period of a year form the basis for annual estimates of the health characteristics of the U.S. population and the analysis trends in these characteristics. In the sample adult core, one adult per sampled family was randomly selected and asked to complete the sample adult questionnaire. In 2010, the final response rate for the sample adult core was 60.8% [18].

HepA vaccination coverage was determined using the following sample adult core survey question: “The hepatitis A vaccine is given as a two dose series routinely to some children starting at 1 year of age, and to some adults and people who travel outside the United States. Although it can be given as a combination vaccine with hepatitis B, it is different from the hepatitis B shot, and has only been available since 1995. Have you ever received the hepatitis A vaccine?” An affirmative answer to the aforementioned question prompted a second question concerning how many doses respondents received: “How many hepatitis A shots did you receive?” Persons from developed countries who travel to developing countries (most of developing countries with high or intermediate HAV endemicity) are at substantial risk for acquiring hepatitis A [2,5]. To determine travel status, respondents were asked “Have you ever traveled outside of the United States to countries other than Europe, Japan, Australia, New Zealand or Canada, since 1995?” For the purposes of this study we will refer to travelers to HAV endemic areas as “travelers”.

Vaccination coverage and series completion were stratified by the following demographic and other characteristics: travel status (traveled to a country of high or intermediate HAV endemicity, not traveled), age group [18–25, 26–29, 40–49], sex (male, female), race/ethnicity (non-Hispanic white only, non-Hispanic black only, Hispanic, Asian, and others (including American Indian/Alaska Native (AI/AN), and multiple race)), marital status (married, widowed/divorced/separated, never married), educational level (high school or less, above high school), employment status (employed, not employed), poverty level (at or above poverty, below poverty), region of residence (Northwest, Midwest, South, West), U.S. born status (born in the US, not born in the US), number of physician contacts in the previous year (none, 1, 2–3, 4–9, 10), hospitalization in the past year (yes, no), place of routine health care (clinic or health center, doctor’s office or health maintenance organization (HMO)), health insurance status (yes, no), ever lived with hepatitis patients (yes, no), ever had chronic liver diseases (yes, no), HepB vaccination (yes, no), influenza vaccination in the past year (yes, no), and behavioral risk level for hepatitis B infection (high risk or non-high risk). Since persons from developed countries who travel to developing countries (most of developing countries with high or intermediate HAV endemicity) are at substantial risk for acquiring hepatitis A [2,5], we considered persons who traveled outside the United States to countries other than Europe, Japan, Australia, New Zealand, or Canada as having traveled to countries with high or intermediate HAV endemicity. Behavioral risks for HBV infection were included in the analysis because it includes persons who are indicated for HepA vaccination (MSM, IDU), with the caveat that it also includes others with behavioral risk for HIV and HepB which are not indications for HepA vaccination. Individuals with behavioral risks for HBV infection were defined as persons who considered themselves at high risk for HIV infection, or reported having a sexually transmitted disease other than HIV/AIDS during the previous five [5] years, or reported *any* one of the following risk factors: male sex with men, injection of street drugs, ever traded sex for money or drugs, HIV positive, ever had sex with someone with any of the aforementioned risk factors, and hemophilia with receipt of clotting factor concentrates. Non-high risk individuals were defined as persons without any of the aforementioned risk factors. All variables listed above in the bi-variable analysis were also included multivariable model except for HepB

vaccination because of the significant correlation between receipt of HepA vaccination and HepB vaccination could distort the model.

We used SUDAAN statistical software (Research Triangle Institute, Research Triangle Park, NC) to calculate point estimates and 95% confidence intervals (CIs) of vaccine coverage and series completion [19]. All analyses were weighted to reflect the age, sex, and race/ethnicity of the U.S. non-institutionalized, civilian population. Bi-variable analysis was conducted using a chi-square to test population distributions between travelers and non-travelers. We used chi-square tests to test the difference in vaccination coverage and series completion by travel status and within each demographic and other characteristic category. Logistic regression was used to determine adjusted vaccination coverage and series completion rates (i.e., the predictive margins) among travelers only. Predictive margins are a type of direct standardization that averages the predicted values from the logistic model, controlling for potential confounders [20,21]. A separate logistic regression model was conducted among all persons 18–49 years including travel status as an independent variable to determine if travel status was an independent predictor of vaccination.

### 3. Results

The 2010 NHIS surveyed 14,755 adults 18–49 years; 5,561 (36.6%) reported traveling to a country of high or intermediate HAV endemicity. The overall population was largely non-Hispanic white (62.8%), insured (75.0%), employed (72.2%), had greater than a high school education (61.7%) and lived at or above the federal poverty line (83.1%). Distribution of travelers and non-travelers differed by employment status, poverty level, health insurance, and U.S. born status (Table 1). Distribution of travelers and non-travelers also differed by most other socio-demographic and access to care characteristics (Table 1). Overall, 29.7% travelers 18–49 years were not born in the United States (Table 1), and 26.9% of those were Asian (data not shown).

#### 3.1. Bivariate analysis of HepA coverage ( 1 dose) and series completion ( 2 doses)

HepA coverage ( 1 dose) is shown in Table 2. Overall, 26.6% (95% CI = 24.9–28.3%) of adult travelers received 1 dose of vaccine compared with 12.7% (95% CI = 11.7–13.7%) among non-travelers ( $P$ -value < 0.001). Series completion ( 2 doses) was also higher among travelers at 16.9% (95% CI = 15.4–18.4%) compared with 7.6% (95% CI = 6.8–8.4%) among non-travelers ( $P$ -value < 0.001) (Table 2).

Among adult travelers, the following characteristics were associated with increased HepA coverage on bivariate analysis: younger age (persons 18–25 years had the highest coverage and those 40–49 years the lowest); being “Asian” or “other” race/ethnicity; never married; having above a high school education; unemployed; increasing number of physician contacts; place of routine healthcare being a clinic or doctor’s office or some other place; having medical insurance; having a high-risk behavior for hepatitis B infection; ever had chronic liver diseases; received influenza vaccination in the previous year; and ever having received hepatitis B vaccination. Similar associations were seen among non-travelers and for series completion for both travelers and non-travelers.

### 3.2. Multivariable analysis of HepA coverage and series completion among travelers

On multivariable analysis among all respondents with travel status as an independent variable, coverage (1 dose) and series completion (2 doses) were higher (prevalence ratios 2.1, 2.0, respectively,  $P$ -values  $< 0.001$ ) among those who reported travel to a country with high or intermediate HAV endemicity compared to non-travelers (data not shown). On multivariable analysis among travelers, HepA coverage (1 dose) and series completion (2 doses) were higher for travelers 18–25 years (prevalence ratios 2.3, 2.8, respectively,  $P$ -values  $< 0.001$ ), and for travelers 26–39 years (prevalence ratios 1.5, 1.5, respectively,  $P$ -value  $< 0.001$ ,  $P$ -value = 0.002, respectively) compared to travelers 40–49 years. Other characteristics independently associated with a higher likelihood of HepA receipt among travelers included Asian race/ethnicity, male sex, never having been married, having a high school or higher education, living in the western United States, having greater number of physician contacts or receipt of influenza vaccination in the previous year (Table 3). Similar associations were seen for series completion, among travelers, with the exception that “other” race/ethnicity and sex were no longer statistically significant. Additionally, living in the western United States was also independently associated with a higher likelihood of HepA receipt in younger age group among travelers and non-travelers (data not shown).

## 4. Discussion

This study used a representative national survey to assess self-reported HepA vaccination coverage among adult travelers to countries of high or intermediate hepatitis A endemicity in 2010. Travel status was an independent predictor of vaccination HepA coverage (1 dose); however, series completion (2 doses) among adult travelers and non-travelers 18–49 years was low. Coverage was higher among younger travelers and travelers who are Asians. In addition, male sex, never having been married, having a high school or higher education, living in the western United States, having greater number of physician contacts or receipt of influenza vaccination in the previous year were independently associated with a higher likelihood of HepA vaccination among travelers.

There are several factors that might contribute to low HepA vaccination among travelers to HAV endemic countries. Many travelers to nearby international destinations may fail to seek travel health advice [13] because of lack of awareness of the risk for travel associated infection [22] and travel related vaccination recommendations. Some travelers, such as business travelers, journalists and relief workers may be notified of travel on short notice and have little time for vaccination prior to departure even though these travelers should be vaccinated for planned travel to protect themselves and minimize business costs and liability [23]. Travelers may believe that travel of short duration, to resorts or on tours, will pose little risk of travel related diseases [22]. This belief may also be likely for travelers visiting friends and relatives in endemic areas. Low HepA vaccination is a public health issue for non-travelers as well (e.g., MSM) in addition to international travelers [5,17,24–26]. Additional factors that may contribute to low vaccination coverage include: the historical lack of national programs that support vaccine purchase and infrastructure for adult vaccine administration and limited private and public sector reimbursement for adult vaccination [5,17,24–26].



Age was strongly associated with reported HepA vaccination among travelers. Our study indicated that persons 18–25 and 26–39 years were approximately two to three times more likely to report receiving HepA than those 40–49 years after controlling for other demographic and access to care variables. Higher vaccination coverage among younger adults may be due to one or more factors. First, the incidence of hepatitis A is higher among younger adults compared to older adults; higher coverage may reflect a targeted effort by health care providers to immunize persons perceived to have greater risk [6,7]. Higher vaccination coverage among younger adults 18–25 years may also reflect the aging of the cohort of children who were vaccinated under the childhood and adolescent HepA vaccination recommendations [2,5,14,25,26].

Coverage was very low among persons 40–49 years at 20% (vaccine coverage) and 12% (series completion). Low coverage among older travelers is concerning because persons over 40 years of age are at greater risk of serious and even fatal consequences of HAV infection. Adults over 50 years of age have an approximately sixfold increased risk of death from HAV infection [13].

Both race/ethnicity and sex were associated with hepatitis A vaccination among travelers. Vaccination coverage was significantly higher among travelers classified as Asian race/ethnicity. Higher coverage among Asians may, in part, reflect Asians may be vaccinated prior to travel to their country of origin to visit family or friends. Male travelers were more likely to be vaccinated than their female counterparts. The reason for this disparity may be related to other risk factors for HepA vaccination (MSM, IDU). In addition, male travelers had a higher employment rate than females and thus may have had more chance to have business trip and being vaccinated through their employment benefits. The reason for this disparity merits further investigation.

Higher education level and increasing number of physician visits per year were both associated with HepA receipt among travelers. This result is consistent with other studies of adult vaccination [24–29]. In general, persons with less than a high school education experience more barriers to health care possibly due to lack of knowledge about preventive services [30–32]. It is not surprising that travelers with a greater number of physician contacts have higher vaccination coverage, since physician recommendations for vaccination are strongly associated with a patient's decision to get vaccinated [33–35]. Persons who have more frequent physician contact also have more opportunities to discuss travel plans and receive travel health related advice.

Living in the western United States Region was independently associated with a higher HepA receipt among travelers. Higher vaccination coverage was also observed in younger age group among travelers and non-travelers in the western United States Region. This result may reflect the aging of the cohort of children who were vaccinated under the initial childhood and adolescent HepA vaccination recommendations [2,5,14,25,26]. Vaccination was recommended initially for children and adolescents among 11 states where hepatitis A incidence were substantially higher than other U.S. regions [2,5,14,25,26]. Of those 11 states, 9 were western states.

HepB vaccination was significantly associated with higher HepA vaccination coverage among travelers in the bi-variable analysis even though HepB vaccination was excluded in multivariable model because of the significant correlation between receipt of hepatitis A vaccination and hepatitis B vaccination could distort the model. This association may reflect providers' awareness of the possible need for both vaccines among persons traveling to countries with high or intermediate HAV and HBV (hepatitis B virus) endemicity [36]. Reported receipt of influenza vaccination in the past year was also associated with HepA vaccination among travelers. Annual influenza vaccination could provide a platform for delivering or recommending HepA vaccine to those who needed and thus may help increase vaccination coverage.

To increase vaccination coverage, public health programs and health-care providers are encouraged to inform adults receiving preventive clinical services of potential benefits of HepA vaccination. Greater vaccination coverage can be achieved by routinely assessing patients' vaccination status, using standing orders for vaccination, incorporating vaccination information into electronic medical records, using immunization information systems (IIS) [37,38], and reminder-recall systems [35]. Providers should ask their patients' upcoming travel plans and recommend and offer travel related vaccinations to their patients [9]. Increased efforts are needed to improve vaccination levels among travelers with lower vaccination coverage, particularly travelers 40–49 years or those with lower educational levels. Providers should recommend and encourage travelers 40–49 years or travelers with lower education to receive vaccination since they are less likely to have been vaccinated. Further studies are needed to examine the contribution of other factors so that we can more fully understand the complex causes of these patterns and especially ways to overcome barriers blocking higher coverage.

The findings in this study are subject to limitations. Data for this study were collected by self report and vaccination was not verified by medical records and thus may be subject to recall bias or lack of knowledge about the different types of hepatitis vaccines. Thus, coverage estimate from the NHIS may under or over report of hepatitis A vaccination among both travelers and non-travelers. However, previous studies have found that self-report of pneumococcal vaccination by adults was moderately or highly sensitive and moderately specific compared with reviews of medical records [39,40], with 1–5% net over-reporting bias. Self-report of influenza vaccination by adults also has been shown to have high sensitivity and moderate specificity, with 5–11% net over reporting bias [39].

This study documents national hepatitis A vaccination coverage among persons 18–49 years reported traveling to a country of high or intermediate endemicity, and underscores the need to continue monitoring hepatitis A vaccination coverage. Although travel status was an independent predictor of hepatitis A vaccination in our study, HepA vaccination among adult travelers to HAV endemic areas was low at approximately 27%. With the passage of the Affordable Care Act, all ACIP recommended vaccines would be covered by insurance providing greater access to vaccination. To further improve HepA vaccination coverage and reduce the burden of travel related HAV infection in the United States, healthcare providers are encouraged to adopt strategies to identify candidates for HepA vaccination, and to ensure that traveling adults and all adults at increased risk for HAV infection or seeking protection



from HAV infection are offered hepatitis A vaccine [5,16,36,41–44]. Travelers, especially health travelers with no provider visit, should see their doctor to discuss their travel related immunizations and other preventive care services since CDC recommended that international travelers should schedule a visit to a primary doctor or a travel medicine provider 4–6 weeks before trip [44].

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**Table 1**

Sample characteristics of participants 18–49 years in the United States, by travel status, demographic and access-to-care variables – NHIS 2010.

Characteristic	All adults		Traveled <sup>a</sup>		Not traveled	
	Sample	Weighted %	Sample	Weighted %	Sample	Weighted %
Total	14,755		5561	36.6	13,949	93.0
Age						
	18–25	3239	25.2	21.6	969	27.4 <sup>b</sup>
	26–39	6783	42.4	46.8	1941	39.8
	40–49	4733	32.4	31.6	2246	32.8
Sex						
	Male	6379	49.8	52.9	3983	48.0 <sup>b</sup>
	Female	8016	50.2	47.1	5211	52.0
Race/ethnicity						
	Non-hispanic White	7405	62.3	59.3	4742	64.0 <sup>b</sup>
	Non-hispanic Black	2395	12.8	7.6	1889	15.7
	Hispanic	3597	17.8	21.9	2017	15.5
	Asian	1045	5.2	9.7	330	2.6
	Other	313	1.9	1.5	216	2.2
Marital status						
	Married	6289	49.0	57.0	3501	44.4 <sup>b</sup>
	Widowed/divorced/separated	1975	9.0	6.8	1386	10.2
	Never married	6469	42.0	36.2	4289	45.4
Education						
	High school or less	5812	38.3	25.9	4324	45.5 <sup>b</sup>
	Above high school	8901	61.7	74.1	4834	54.5
Employment status						
	Employed	10,515	72.2	76.8	6292	69.5 <sup>b</sup>
	Not employed	4233	27.8	23.2	2898	30.5
Poverty level	At or above poverty	10,562	83.1	88.6	6189	79.9 <sup>b</sup>

Characteristic	All adults			Traveled <sup>a</sup>			Not traveled		
	Sample	Weighted %		Sample	Weighted %		Sample	Weighted %	
<i>Region</i>									
Below poverty	2997	16.9		797	11.4		2200	20.1	
Northeast	2161	16.5		824	16.9		1337	16.3 <sup>b</sup>	
Midwest	3197	23.2		1043	20.5		2154	24.7	
South	5427	35.5		1862	31.7		3565	37.7	
West	3970	24.8		1832	30.9		2138	21.3	
<i>US born</i>									
Yes	11,048	80.5		3546	70.3		7502	86.3 <sup>b</sup>	
No	3701	19.5		2013	29.7		1688	13.7	
<i>Physician contacts within past year</i>									
None	3976	26.0		1307	22.1		2669	28.2 <sup>b</sup>	
1	2652	18.1		1011	18.2		1641	18.0	
2–3	3696	25.5		1517	28.1		2179	24.0	
4–9	2828	19.7		1146	21.5		1682	18.7	
10	1576	10.7		571	10.1		1005	11.1	
<i>Hospitalization within past year</i>									
Yes	1093	7.1		348	5.9		745	7.8 <sup>b</sup>	
No	13,658	92.9		5211	94.1		8447	92.2	
<i>Place of routine health care</i>									
Clinic or health center	3264	19.7		1134	18.5		2130	20.4 <sup>b</sup>	
Doctor's office or HMO <sup>c</sup>	8128	59.4		3239	62.6		4889	57.6	
Some other place	563	3.4		167	2.6		396	3.8	
None	2685	17.5		987	16.3		1698	18.2	
<i>Health insurance</i>									
Yes	10,765	75.0		4343	80.2		6422	72.0 <sup>b</sup>	
No	3941	25.0		1201	19.8		2740	28.0	
<i>High-risk behavior with HepB indication<sup>d</sup></i>									
Yes	1161	7.1		389	6.3		772	7.6 <sup>b</sup>	

Characteristic	All adults			Traveled <sup>a</sup>			Not traveled		
	Sample	Weighted %		Sample	Weighted %		Sample	Weighted %	
<i>Ever lived with a hepatitis patients</i>	No	13,517	92.9	5145	93.7		8372	92.4	
	Yes	552	4.0	231	4.5		321	3.7	
<i>Persons with chronic liver diseases</i>	No	13,843	96.0	5164	95.5		8679	96.3	
	Yes	120	0.7	43	0.7		77	0.7	
<i>Influenza vaccination</i>	No	14,622	99.3	5516	99.3		9106	99.3	
	Yes	2096	24.5	882	28.2		1214	22.4 <sup>b</sup>	
<i>Ever received hepatitis B vaccination</i>	No	6818	75.5	2445	71.8		4373	77.6	
	Yes	5645	41.7	2447	48.4		3198	37.9 <sup>b</sup>	
	No	8134	58.3	2706	51.6		5428	62.1	

<sup>a</sup>Persons from developed countries who travel to developing countries (most of developing countries with high or intermediate HAV endemicity) are at substantial risk for acquiring hepatitis A. Persons traveled outside the United States to countries other than Europe, Japan, Australia, New Zealand, or Canada were considered having traveled to countries with high or intermediate HAV endemicity.

<sup>b</sup>Significant difference between travelers and non travelers (by chi-square test,  $P < 0.05$ ).

<sup>c</sup>Health maintenance organization.

<sup>d</sup>Includes persons who considered themselves at high risk for HIV infection, persons who reported having a sexually transmitted disease other than HIV/AIDS during the previous 5 years, and persons who reported any one of the following risk factors: hemophilia with receipt of clotting factor concentrates, men who have sex with men, injecting street drugs, trading sex for money or drugs, testing positive for HIV, or having sex with someone with any of these risk factors.



Table 2

Percentage of persons 18–49 years who reported receiving hepatitis A vaccination, United States, by travel status, demographic and access-to-care variables – NHIS 2010.

Characteristic	Vaccination coverage with 1 dose among persons 18–49 years traveled <sup>a</sup> % (95% CI)	Vaccination coverage with 1 dose among persons 18–49 years not traveled % (95% CI)	P-value <sup>b</sup>	Vaccination coverage with 2 dose among persons 18–49 years not traveled <sup>a</sup> % (95% CI)	Vaccination coverage with 2 dose among persons 18–49 years not traveled % (95% CI)	P-value <sup>b</sup>
Total	26.6 (24.9–28.3)	12.7 (11.7–13.7)	<0.001	16.9 (15.4–18.4)	7.6 (6.8–8.4)	<0.001
Age						
18–25	37.5 (33.3–41.9) <sup>c</sup>	20.5 (18.2–23.1) <sup>c</sup>	<0.001	26.4 (22.5–30.8) <sup>c</sup>	12.5 (10.6–14.6) <sup>c</sup>	<0.001
26–39	26.3 (24.3–28.3) <sup>c</sup>	12.2 (10.9–13.5) <sup>c</sup>	<0.001	16.3 (14.6–18.1) <sup>c</sup>	7.4 (6.4–8.5) <sup>c</sup>	<0.001
40–49 <sup>d</sup>	20.0 (17.7–22.6)	7.1 (6.1–8.3)	<0.001	11.9 (10.1–14.0)	4.2 (3.3–5.2)	<0.001
Sex						
Male <sup>d</sup>	26.5 (24.2–28.9)	11.4 (10.1–12.9)	<0.001	16.7 (14.8–18.8)	6.8 (5.8–7.9)	<0.001
Female	26.6 (24.3–29.2)	13.8 (12.6–15.1) <sup>c</sup>	<0.001	17.0 (14.9–19.4)	8.3 (7.4–9.4) <sup>c</sup>	<0.001
Race/ethnicity						
Non-hispanic White <sup>d</sup>	26.4 (24.1–28.9)	11.8 (10.5–13.1)	<0.001	17.5 (15.5–19.7)	7.1 (6.2–8.2)	<0.001
Non-hispanic Black	27.7 (23.2–32.7)	14.0 (12.3–15.9) <sup>c</sup>	<0.001	16.4 (12.4–21.4)	8.6 (7.3–10.2)	0.001
Hispanic	22.5 (19.8–25.5) <sup>c</sup>	13.5 (11.5–15.8)	<0.001	13.4 (11.1–16.0) <sup>c</sup>	8.1 (6.5–10.0)	<0.001
Asian	33.2 (28.2–38.7) <sup>c</sup>	13.5 (9.8–18.4)	<0.001	20.1 (15.9–25.0)	5.3 (3.1–9.0)	<0.001
Other	42.9 (30.5–56.2) <sup>c</sup>	22.5 (15.7–31.2) <sup>c</sup>	<0.001	25.6 (16.3–37.8)	13.6 (8.2–21.7)	<0.001
Marital status						
Married	23.7 (21.7–25.8) <sup>c</sup>	10.5 (9.2–11.9) <sup>c</sup>	<0.001	14.3 (12.7–16.0) <sup>c</sup>	5.9 (4.9–7.0) <sup>c</sup>	<0.001
Widowed/divorced/separated	19.9 (16.0–24.4)	10.9 (9.2–12.8) <sup>c</sup>	0.001	12.9 (9.4–17.4)	7.4 (6.0–9.1)	0.010
Never married <sup>d</sup>	32.5 (29.7–35.4)	15.3 (13.8–17.0)	<0.001	22.0 (19.3–24.9)	9.4 (8.3–10.7)	<0.001
Education						
High school or less <sup>d</sup>	19.3 (16.5–22.5)	9.9 (8.8–11.3)	<0.001	10.6 (8.5–13.1)	5.5 (4.6–6.6)	<0.001
Above high school	29.1 (27.1–31.1) <sup>c</sup>	15.0 (13.6–16.5) <sup>c</sup>	<0.001	19.0 (17.3–21.0) <sup>c</sup>	9.4 (8.3–10.5) <sup>c</sup>	<0.001
Employment status						

Characteristic	Vaccination coverage with 1 dose among persons 18–49 years traveled <sup>a</sup> % (95% CI)	Vaccination coverage with 1 dose among persons 18–49 years not traveled % (95% CI)	<i>P</i> -value <sup>b</sup>	Vaccination coverage with 2 dose among persons 18–49 years traveled <sup>a</sup> % (95% CI)	Vaccination coverage with 2 dose among persons 18–49 years not traveled % (95% CI)	<i>P</i> -value <sup>b</sup>
<i>Poverty level</i>	Employed <sup>d</sup>	25.4 (23.6–27.3)	11.7 (10.6–12.8)	<0.001	6.9 (6.1–7.9)	<0.001
	Not employed	30.6 (27.4–34.0) <sup>c</sup>	15.0 (13.3–16.9) <sup>c</sup>	<0.001	9.2 (7.9–10.6) <sup>c</sup>	<0.001
<i>Region</i>	At or above poverty	26.2 (24.5–28.1)	12.2 (11.1–13.4)	<0.001	7.5 (6.7–8.5)	<0.001
	Below poverty <sup>d</sup>	29.1 (24.5–34.2)	13.5 (11.7–15.5)	<0.001	7.9 (6.5–9.4)	<0.001
<i>US born</i>	Northeast <sup>d</sup>	24.8 (20.6–29.4)	9.6 (7.5–12.2)	<0.001	5.3 (3.8–7.4)	<0.001
	Midwest	25.2 (22.4–28.2)	10.2 (8.5–12.2)	<0.001	5.8 (4.5–7.4)	<0.001
	South	25.5 (22.6–28.5)	13.2 (11.5–15.0) <sup>c</sup>	<0.001	8.6 (7.3–10.1) <sup>c</sup>	<0.001
	West	29.7 (26.4–33.2)	17.2 (15.0–19.7) <sup>c</sup>	<0.001	9.7 (8.1–11.6) <sup>c</sup>	<0.001
<i>Physician contacts within past year</i>	Yes	27.2 (25.2–29.4)	12.6 (11.5–13.7)	<0.001	7.7 (6.9–8.6)	<0.001
	No <sup>d</sup>	25.0 (22.4–27.8)	13.3 (11.3–15.7)	<0.001	6.6 (5.1–8.5)	<0.001
<i>Hospitalization within past year</i>	None <sup>d</sup>	21.2 (18.5–24.2)	10.1 (8.7–11.8)	<0.001	5.8 (4.8–7.1)	<0.001
	1	25.2 (22.0–28.7)	11.6 (9.7–13.8)	<0.001	6.7 (5.3–8.3)	<0.001
	2–3	28.3 (25.4–31.4) <sup>c</sup>	13.6 (11.8–15.6) <sup>c</sup>	<0.001	8.4 (6.8–10.2) <sup>c</sup>	<0.001
	4–9	28.2 (24.8–31.8) <sup>c</sup>	15.5 (13.4–17.9) <sup>c</sup>	<0.001	8.9 (7.2–10.8) <sup>c</sup>	<0.001
<i>Place of routine health care</i>	10	32.4 (27.8–37.5) <sup>c</sup>	14.4 (11.8–17.4) <sup>c</sup>	<0.001	9.9 (7.7–12.6) <sup>c</sup>	<0.001
	Yes	28.3 (22.9–34.5)	11.9 (9.5–14.7)	<0.001	7.7 (5.7–10.3)	0.002
<i>Place of routine health care</i>	No <sup>d</sup>	26.4 (24.7–28.2)	12.7 (11.7–13.8)	<0.001	7.6 (6.8–8.4)	<0.001
	Clinic or health center	29.2 (25.8–32.9) <sup>c</sup>	14.1 (12.1–16.2) <sup>c</sup>	<0.001	8.3 (6.7–10.1) <sup>c</sup>	<0.001
	Doctor's office or HMO <sup>e</sup>	26.5 (24.4–28.7)	13.0 (11.7–14.4) <sup>c</sup>	<0.001	7.9 (6.9–9.0) <sup>c</sup>	<0.001
	Some other place	35.1 (26.7–44.5) <sup>c</sup>	16.8 (12.8–21.7) <sup>c</sup>	<0.001	11.1 (8.1–15.0) <sup>c</sup>	0.009

Characteristic	Vaccination coverage with 1 dose among persons 18–49 years traveled <sup>a</sup> % (95% CI)	Vaccination coverage with 1 dose among persons 18–49 years not traveled % (95% CI)	<i>P</i> -value <sup>b</sup>	Vaccination coverage with 2 dose among persons 18–49 years traveled <sup>a</sup> % (95% CI)	Vaccination coverage with 2 dose among persons 18–49 years not traveled % (95% CI)	<i>P</i> -value <sup>b</sup>
<i>Health insurance</i>						
None <sup>d</sup>	21.6 (18.3–25.3)	9.5 (7.8–11.4)	<0.001	14.3 (11.4–17.8)	5.5 (4.4–7.0)	<0.001
Yes	27.7 (25.7–29.7) <sup>c</sup>	13.0 (11.9–14.1)	<0.001	17.5 (15.9–19.2)	8.0 (7.1–8.9)	<0.001
No <sup>d</sup>	22.1 (18.9–25.5)	11.9 (10.4–13.5)	<0.001	14.3 (11.6–17.6)	6.7 (5.5–8.0)	<0.001
<i>High-risk behavior with HepB indication<sup>f</sup></i>						
Yes	33.6 (27.5–40.3) <sup>c</sup>	19.4 (16.0–23.3) <sup>c</sup>	<0.001	23.9 (18.5–30.2) <sup>c</sup>	10.4 (7.8–13.7) <sup>c</sup>	<0.001
No <sup>d</sup>	26.0 (24.3–27.8)	12.1 (11.1–13.2)	<0.001	16.3 (14.9–17.9)	7.4 (6.7–8.2)	<0.001
<i>Ever lived with a hepatitis patients</i>						
Yes	24.9 (18.5–32.5)	23.3 (17.5–30.3) <sup>c</sup>	0.759	16.0 (10.7–23.2)	13.1 (8.9–18.8) <sup>c</sup>	0.746
No <sup>d</sup>	26.5 (24.8–28.2)	12.1 (11.1–13.1)	<0.001	16.8 (15.3–18.5)	7.3 (6.6–8.1)	<0.001
<i>Persons with chronic liver diseases</i>						
Yes	54.0 (36.6–70.5) <sup>c</sup>	17.3 (8.7–31.5)	<0.001	39.2 (23.9–56.9) <sup>c</sup>	11.4 (4.3–26.7)	0.007
No <sup>d</sup>	26.4 (24.7–28.1)	12.6 (11.7–13.7)	<0.001	16.7 (15.3–18.3)	7.6 (6.8–8.4)	<0.001
<i>Influenza vaccination</i>						
Yes	32.2 (28.3–36.4) <sup>c</sup>	17.3 (14.6–20.4) <sup>c</sup>	<0.001	22.1 (18.4–26.2) <sup>c</sup>	12.2 (9.9–15.0) <sup>c</sup>	<0.001
No <sup>d</sup>	24.7 (22.5–26.9)	10.7 (9.5–12.1)	<0.001	14.4 (12.6–16.3)	6.0 (5.1–7.1)	<0.001
<i>Ever received hepatitis B vaccination</i>						
Yes	49.3 (46.6–52.0) <sup>c</sup>	31.4 (29.1–33.9) <sup>c</sup>	<0.001	33.7 (31.0–36.5) <sup>c</sup>	20.2 (18.2–22.3) <sup>c</sup>	<0.001
No <sup>d</sup>	7.2 (6.0–8.6)	2.7 (2.2–3.3)	<0.001	4.2 (3.3–5.4)	1.4 (1.0–1.9)	<0.001

<sup>a</sup>Persons from developed countries who travel to developing countries (most of developing countries with high or intermediate HAV endemicity) are at substantial risk for acquiring hepatitis A. Persons traveled outside the United States to countries other than Europe, Japan, Australia, New Zealand, or Canada were considered having traveled to countries with high or intermediate HAV endemicity.

<sup>b</sup> $P < 0.05$  for comparisons between travelers and non travelers within each level of each characteristic.

<sup>c</sup> $P < 0.05$  for comparisons within each variable with the indicated reference level.

<sup>d</sup>Reference level.

<sup>e</sup>Health maintenance organization.

includes persons who considered themselves at high risk for HIV infection, persons who reported having a sexually transmitted disease other than HIV/AIDS during the previous 5 years, and persons who reported any one of the following risk factors: hemophilia with receipt of clotting factor concentrates, men who have sex with men, injecting street drugs, trading sex for money or drugs, testing positive for HIV, or having sex with someone with any of these risk factors.

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Table 3

Multivariable logistic regression and predictive marginal prevalence of travelers<sup>a</sup> 18–49 years who reported received hepatitis A vaccination, United States, by demographic and access-to-care variables, NHIS 2010.

Characteristic	Vaccination with 1 dose			Vaccination with 2 dose		
	Adjusted vaccination coverage % (95% CI)	Prevalence ratio (risk ratio) (adjusted) % (95% CI)	P-value <sup>b</sup>	Adjusted vaccination coverage % (95% CI)	Prevalence Ratio (Risk Ratio) (adjusted) % (95% CI)	P-value <sup>b</sup>
<i>Age</i>						
18–25	41.2 (35.2–47.3)	2.3 (1.8–2.9)	<0.001	28.2 (22.4–34.0)	2.8 (2.1–3.8)	<0.001
26–39	25.8 (23.3–28.4)	1.5 (1.2–1.8)	<0.001	15.0 (12.9–17.2)	1.5 (1.2–2.0)	0.003
40–49 <sup>c</sup>	17.8 (14.7–20.9)	Referent		10.0 (7.6–12.3)	Referent	
<i>Sex</i>						
Male <sup>c</sup>	29.0 (26.1–31.9)	Referent		17.2 (14.6–19.9)	Referent	
Female	24.0 (21.1–27.0)	0.8 (0.7–1.0)	0.023	15.0 (12.4–17.6)	0.9 (0.7–1.1)	0.258
<i>Race/ethnicity</i>						
Non-hispanic White <sup>c</sup>	24.3 (21.4–27.2)	Referent		15.2 (12.7–17.7)	Referent	
Non-hispanic Black	30.3 (23.0–37.5)	1.2 (0.9–1.6)	0.125	16.4 (10.4–22.4)	1.1 (0.7–1.6)	0.706
Hispanic	27.1 (22.2–32.0)	1.1 (0.9–1.4)	0.365	17.2 (12.8–21.7)	1.1 (0.8–1.5)	0.462
Asian	37.7 (29.3–46.0)	1.6 (1.2–2.0)	0.003	20.0 (13.6–26.5)	1.3 (0.9–1.9)	0.174
Other	26.1 (13.0–39.1)	1.1 (0.6–1.8)	0.796	13.4 (1.9–24.9)	0.9 (0.4–2.2)	0.779
<i>Marital Status</i>						
Married	24.8 (22.0–27.6)	0.8 (0.7–1.0)	0.573	14.0 (11.7–16.3)	0.7 (0.6–1.0)	0.712
Widowed/divorced/separated	22.9 (16.9–28.9)	0.8 (0.6–1.0)	0.062	15.1 (9.5–20.7)	0.8 (0.5–1.2)	0.023
Never married <sup>c</sup>	29.5 (25.7–33.2)	Referent		19.0 (15.6–22.5)	Referent	
<i>Education</i>						
High school or less <sup>c</sup>	22.5 (18.0–26.9)	Referent		12.2 (8.9–15.5)	Referent	
Above high school	27.8 (25.4–30.2)	1.2 (1.0–1.6)	0.050	17.4 (15.1–19.6)	1.4 (1.0–2.0)	0.024
<i>Employment status</i>						
Employed <sup>c</sup>	25.8 (23.5–28.0)	Referent	0.187	15.8 (13.6–17.9)	1.1 (0.8–1.4)	0.560
Not employed	28.9 (24.7–33.1)	1.1 (1.0–1.3)		17.0 (13.4–20.7)	Referent	
<i>Poverty level</i>						

Characteristic	Vaccination with 1 dose			Vaccination with 2 dose		
	Adjusted vaccination coverage % (95% CI)	Prevalence ratio (risk ratio) (adjusted) % (95% CI)	P-value <sup>b</sup>	Adjusted vaccination coverage % (95% CI)	Prevalence Ratio (Risk Ratio) (adjusted) % (95% CI)	P-value <sup>b</sup>
<i>Region</i>	At or above poverty	26.8 (24.7–29.0)	1.2 (0.9–1.5)	16.2 (14.3–18.1)	1.1 (0.8–1.6)	0.559
	Below poverty <sup>c</sup>	23.3 (17.6–29.0)	Referent	14.5 (9.3–19.8)	Referent	
	Northeast <sup>c</sup>	22.4 (17.2–27.6)	Referent	13.9 (9.7–18.2)	Referent	
	Midwest	27.5 (23.5–31.5)	1.2 (0.9–1.6)	17.6 (13.8–21.4)	1.3 (0.9–1.8)	0.222
<i>US born</i>	South	25.4 (22.0–28.7)	1.1 (0.9–1.5)	16.2 (13.1–19.3)	1.2 (0.8–1.7)	0.392
	West	29.3 (25.6–33.0)	1.3 (1.0–1.7)	16.0 (12.8–19.1)	1.2 (0.8–1.6)	0.455
	Yes	26.5 (24.0–29.1)	1.0 (0.8–1.3)	15.9 (13.8–18.0)	1.1 (0.7–1.3)	0.811
	No <sup>c</sup>	26.3 (21.8–30.8)	Referent	16.5 (12.3–20.7)	Referent	
<i>Physician contacts within past year</i>	None <sup>c</sup>	21.2 (17.4–25.0)	Referent	12.3 (9.1–15.5)	Referent	
	1	24.4 (19.8–28.9)	1.1 (0.9–1.5)	16.1 (12.0–20.3)	1.3 (0.9–1.9)	0.132
	2–3	25.2 (21.5–28.9)	1.2 (0.9–1.5)	14.2 (11.1–17.3)	1.2 (0.8–1.6)	0.417
	4–9	30.0 (25.7–34.4)	1.4 (1.1–1.8)	17.7 (14.0–21.4)	1.4 (1.0–2.0)	0.032
<i>Hospitalization within past year</i>	10	35.9 (29.0–42.8)	1.7 (1.3–2.2)	24.1 (18.1–30.0)	2.0 (1.4–2.8)	<0.001
	Yes	23.5 (16.2–30.7)	0.9 (0.6–1.2)	13.7 (7.8–19.5)	0.8 (0.5–1.3)	0.441
	No <sup>c</sup>	26.7 (24.6–28.8)	Referent	16.3 (14.4–18.1)	Referent	
<i>Place of routine health care</i>	Clinic or health center	26.4 (22.3–30.6)	1.0 (0.8–1.4)	17.3 (13.4–21.2)	1.0 (0.7–1.5)	0.932
	Doctor's office or HMO <sup>d</sup>	26.4 (23.9–28.9)	1.0 (0.8–1.3)	15.4 (13.1–17.6)	0.9 (0.6–1.3)	0.575
	Some other place	34.2 (22.2–46.2)	1.3 (0.9–2.0)	19.3 (12.3–26.3)	1.1 (0.7–1.8)	0.589
	None <sup>c</sup>	25.5 (19.6–31.5)	Referent	17.0 (11.6–22.5)	Referent	
<i>Health insurance</i>	Yes	27.2 (24.9–29.6)	1.2 (0.9–1.5)	16.6 (14.5–18.6)	1.2 (0.8–1.7)	0.300
	No <sup>c</sup>	23.0 (17.8–28.1)	Referent	13.8 (9.3–18.2)	Referent	
<i>High-risk behavior with HepB indication<sup>e</sup></i>						



Characteristic	Vaccination with 1 dose			Vaccination with 2 dose		
	Adjusted vaccination coverage % (95% CI)	Prevalence ratio (risk ratio) (adjusted) % (95% CI)	P-value <sup>b</sup>	Adjusted vaccination coverage % (95% CI)	Prevalence Ratio (Risk Ratio) (adjusted) % (95% CI)	P-value <sup>b</sup>
Ever lived with a hepatitis patients	Yes	32.4 (24.2–40.6)	1.2 (1.0–1.6)	22.1 (14.7–29.5)	1.4 (1.0–2.0)	0.060
	No <sup>c</sup>	26.1 (24.0–28.1)	Referent	15.6 (13.8–17.4)	Referent	
Persons with chronic liver diseases	Yes	26.3 (17.8–34.8)	1.0 (0.7–1.4)	16.0 (8.0–23.9)	1.0 (0.6–1.6)	0.980
	No <sup>c</sup>	26.5 (24.4–28.5)	Referent	16.1 (14.3–17.9)	Referent	
Influenza vaccination	Yes	47.1 (17.5–76.7)	1.8 (1.0–3.4)	24.4 (–4.3–53.0)	1.5 (0.5–4.9)	0.512
	No <sup>c</sup>	26.4 (24.3–28.4)	Referent	16.0 (14.2–17.8)	Referent	
	Yes	31.1 (27.2–35.1)	1.3 (1.1–1.5)	21.6 (17.7–25.4)	1.6 (1.3–2.0)	<0.001
	No <sup>c</sup>	24.6 (22.3–26.9)	Referent	13.8 (11.9–15.8)	Referent	

<sup>a</sup>Persons from developed countries who travel to developing countries (most of developing countries with high or intermediate HAV endemicity) are at substantial risk for acquiring hepatitis A. Persons traveled outside the United States to countries other than Europe, Japan, Australia, New Zealand, or Canada were considered having traveled to countries with high or intermediate HAV endemicity.

<sup>b</sup> $P < 0.05$  for comparisons within each variable with the indicated reference level.

<sup>c</sup>Reference level.

<sup>d</sup>Health maintenance organization.

<sup>e</sup>Includes persons who considered themselves at high risk for HIV infection, persons who reported having a sexually transmitted disease other than HIV/AIDS during the previous 5 years, and persons who reported any one of the following risk factors: hemophilia with receipt of clotting factor concentrates, men who have sex with men, injecting street drugs, trading sex for money or drugs, testing positive for HIV, or having sex with someone with any of these risk factors.